

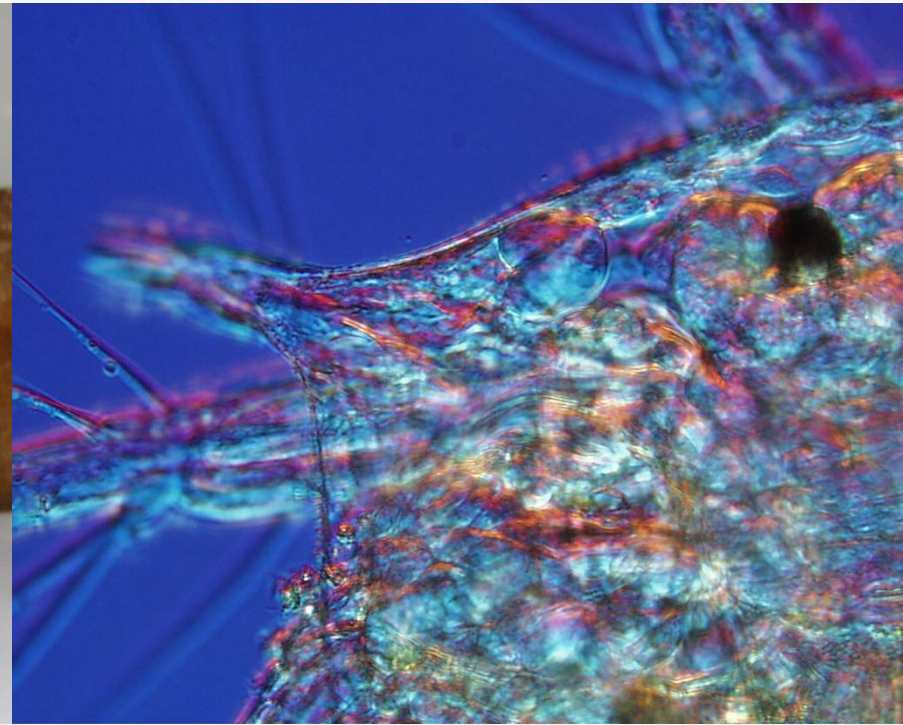
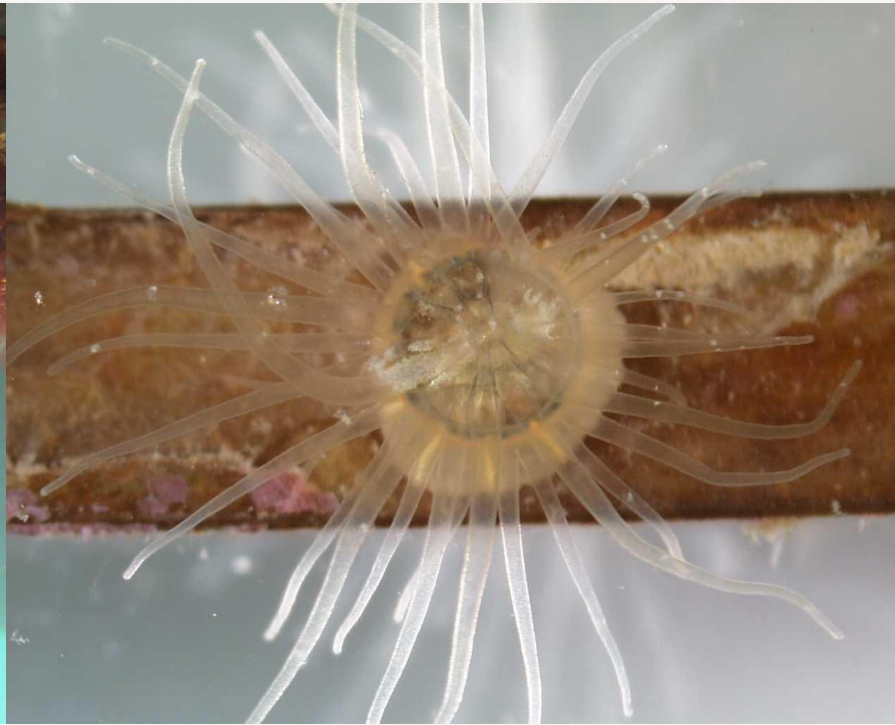


INTRODUCTION TO BIOFOULING

Presentation By: Lisa Drake, PhD
OAS CIP
03 June 2026

Drake Marine Environmental Services
www.drakemes.com

OUTLINE



Kim Holzer, SERC

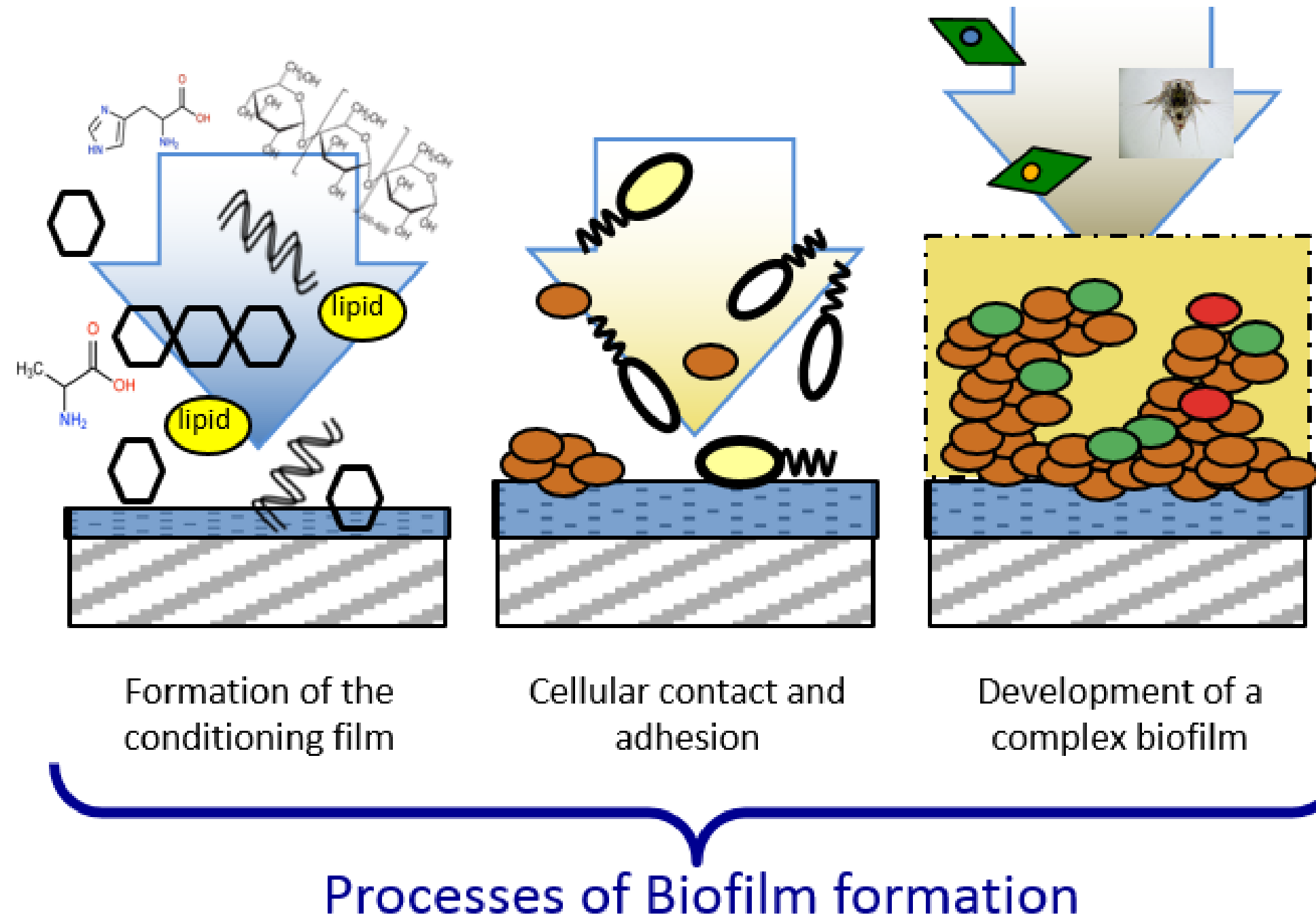
Lisa Drake, DMES

- (Marvelous!) biology
- Management, incentives, and economics
- Solutions
- Relevance to ports

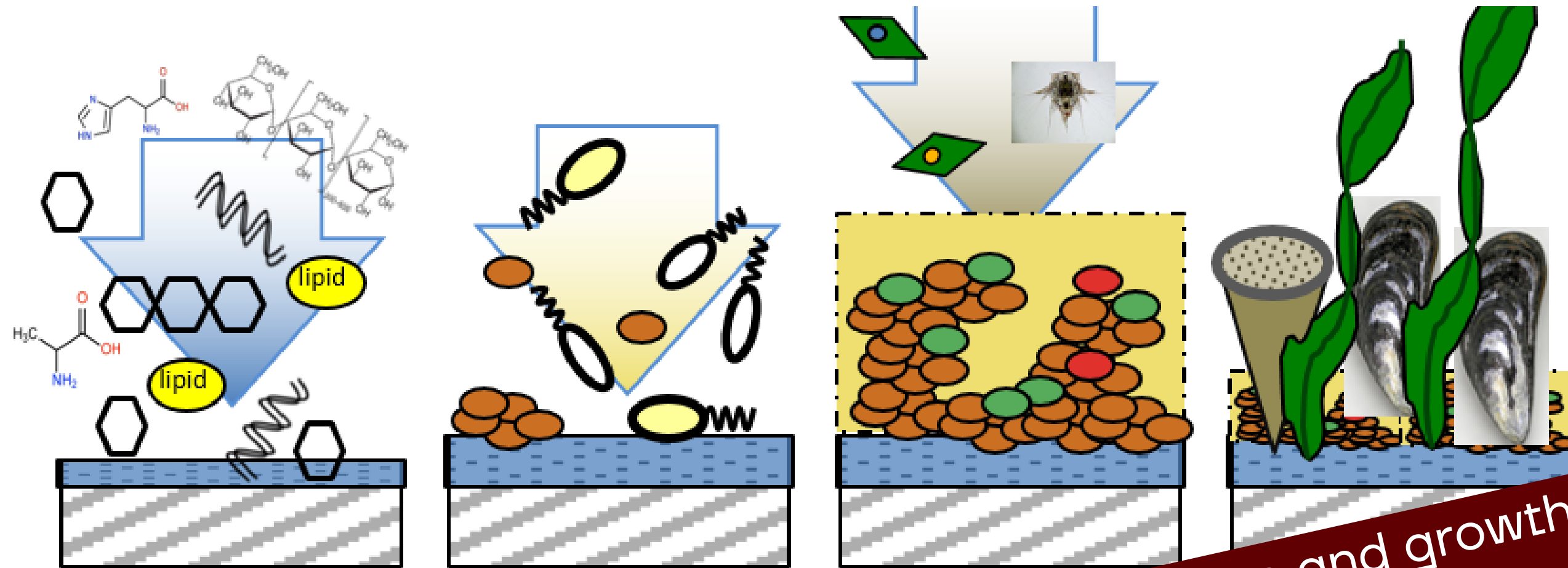
THE PROCESS OF BIOFOULING: BIO *FILMS* ARE FAMILIAR



THE BIOLOGY OF BIOFOULING



THE BIOLOGY OF BIOFOULING



Formation of the conditioning film

Cellular contact and adhesion

Development of the biofilm

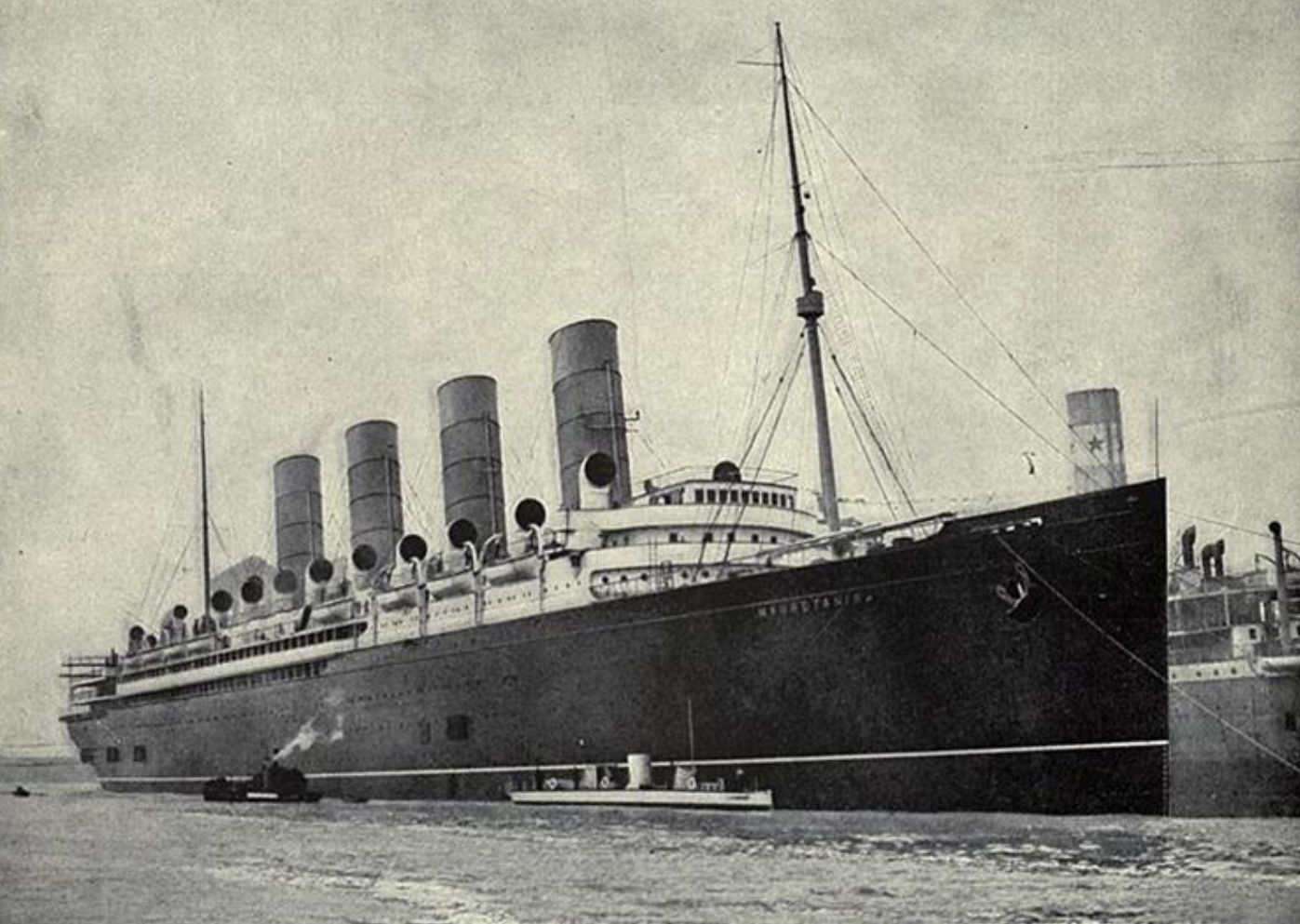
Growth of macroorganisms

Processes of Biofilm formation

Species composition and growth rates vary by Location

Species composition also influenced by ship's operating profile

Processes of Biofouling



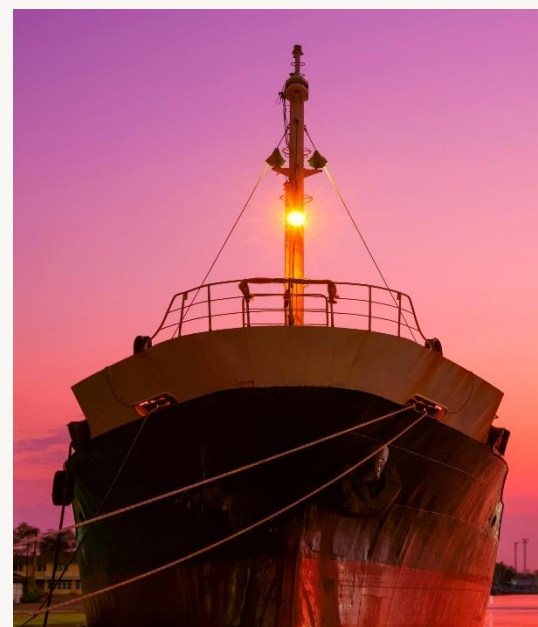
<https://www.historyhit.com/a-timeline-of-the-development-of-maritime-steam-power/>

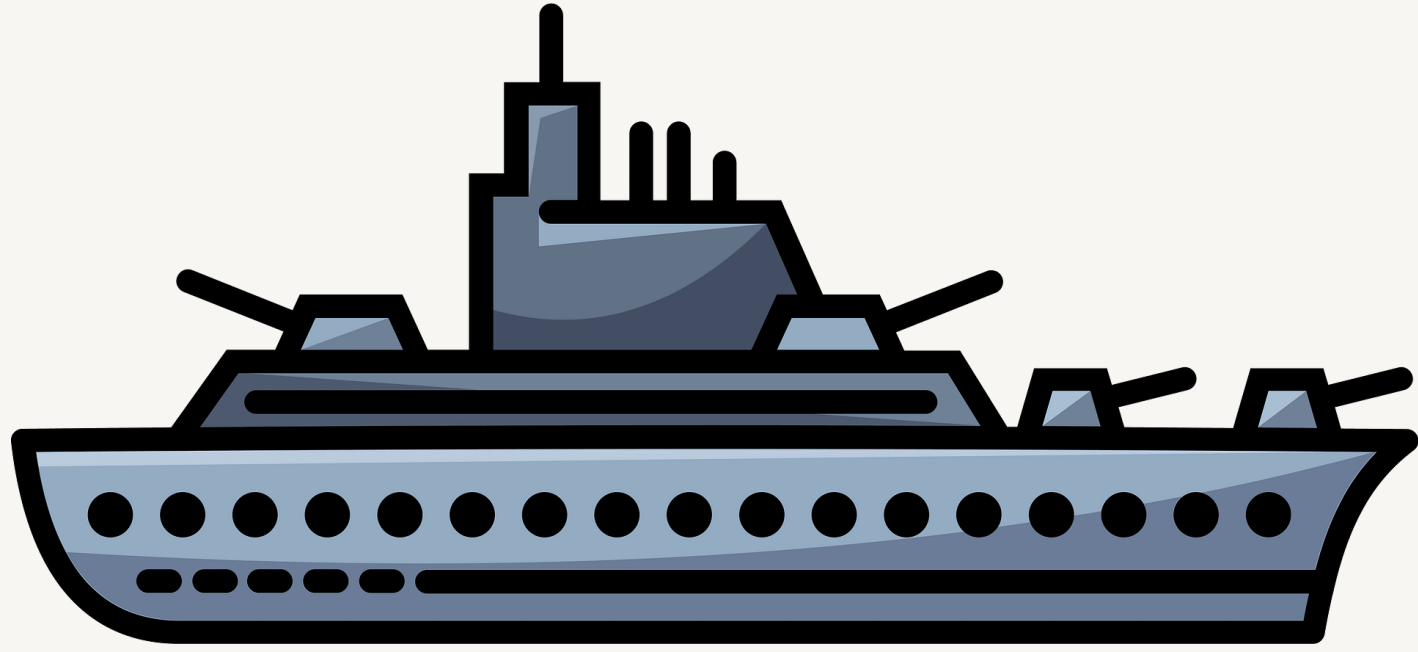
BIOFOULING MANAGEMENT

1

FUEL PENALTY

~10% increase in fuel consumption with a heavy slime layer (Schultz et al. 2011)





<https://creazilla.com/media/clipart/3868258/battleship>

BIOFOULING MANAGEMENT

2

REDUCING DOWNTIME

Military readiness

3

AESTHETICS OF CLEAN HULLS

Yachting industry

4

REDUCING INVASIVE SPECIES

Focus of national and international guidelines and regulations

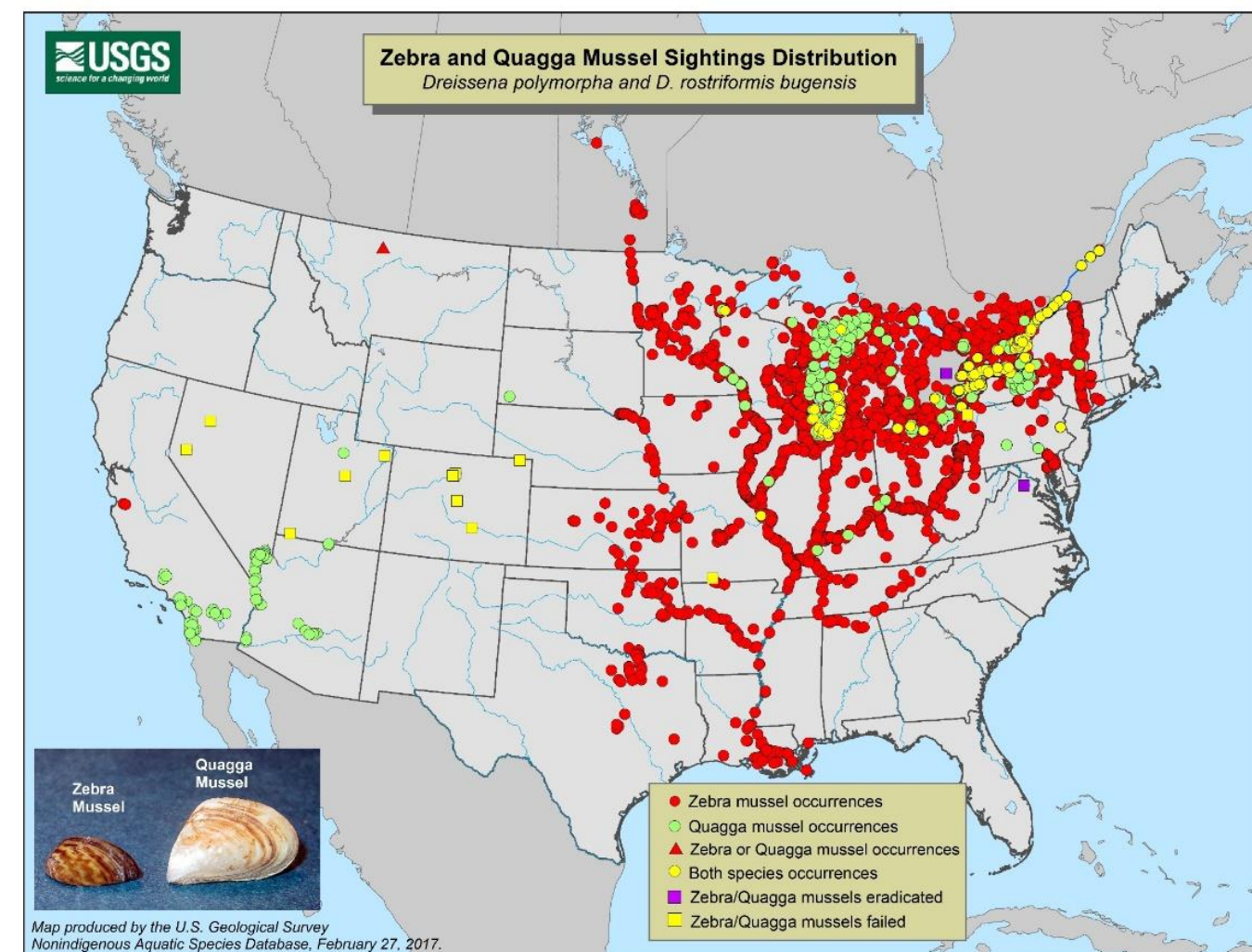
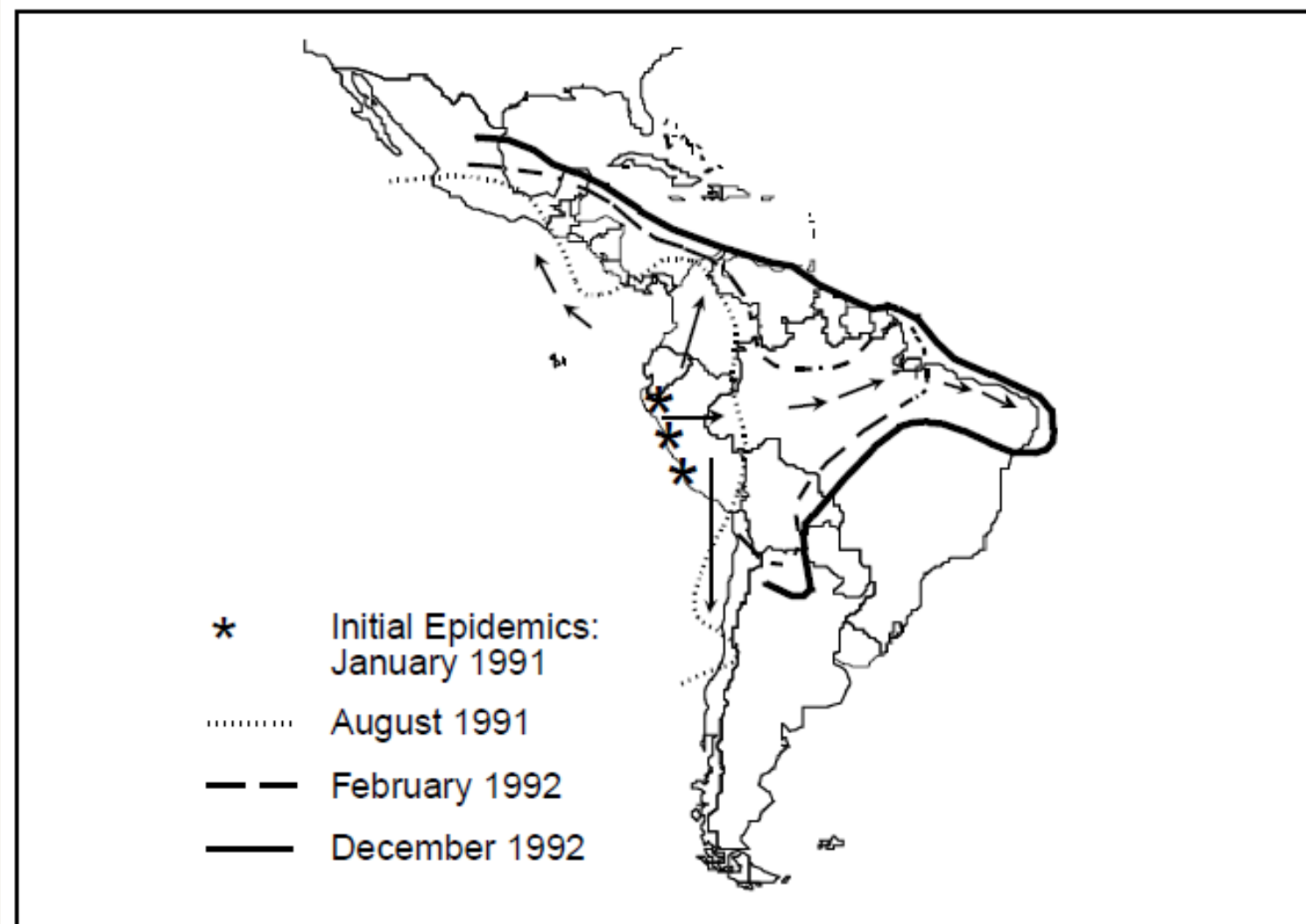


TRANSPORT OF INVASIVE SPECIES BY SHIPS

Historically focused on *ballast water*

However, *biofouling*, appears to be responsible for most of the invasions

→ 55% globally, 60% in Australia (Commonwealth of Australia 2010)



COST OF INVASIONS



DIFFICULT TO ASSESS

- No standard methodology
- No universal database
- Organisms/effects difficult to quantify

Type of Invasions	Region	Years Covered	Cost of Invasive Aquatic Species/year (USD\$)
Aquatic	Global	1960-2020 (60 years)	\$345B total At least \$23B in 2020

BIOFOULING MANAGEMENT

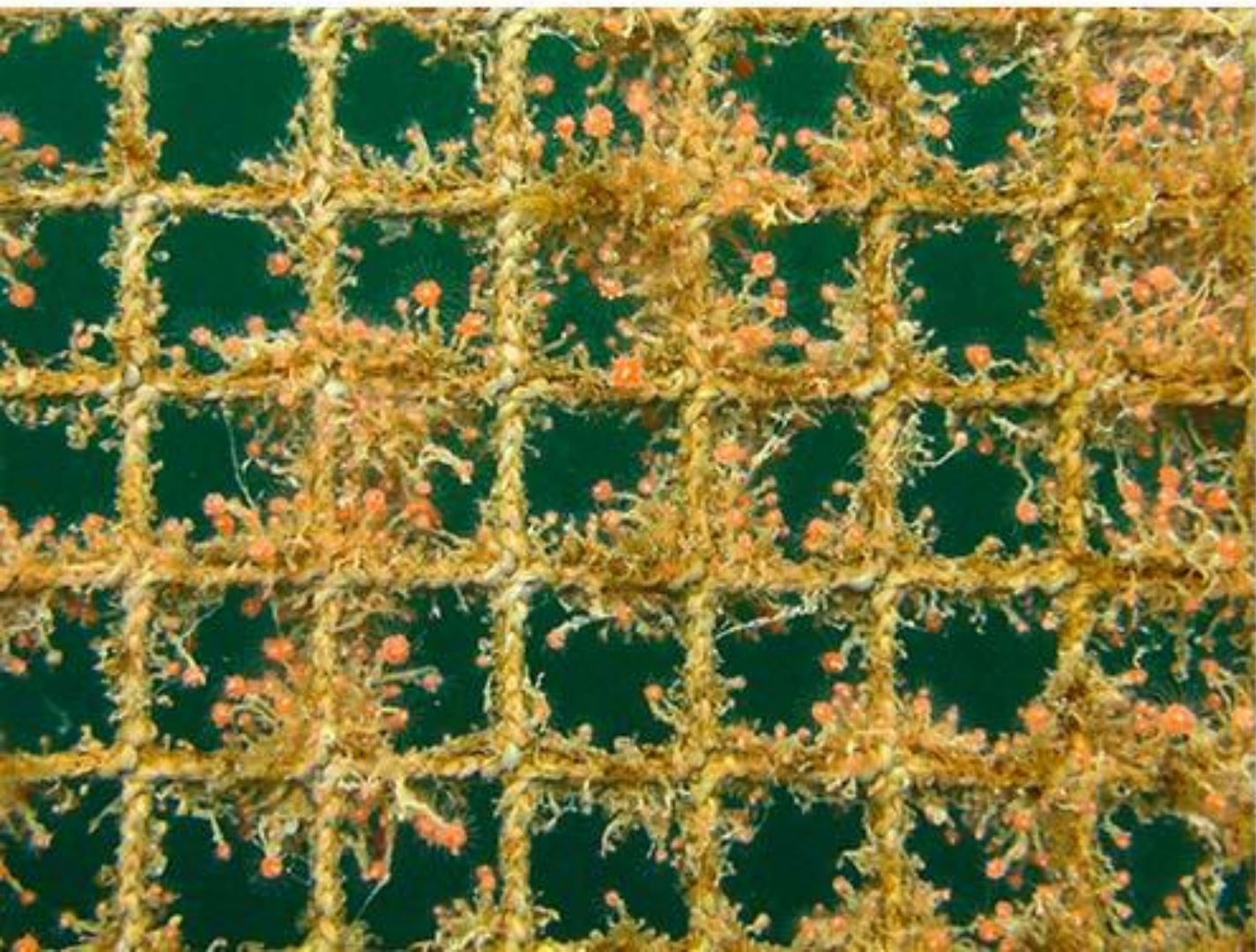
- Coatings, coatings, coatings
- Operations
- Cleaning
 - Must be compatible with coating
 - Most done by divers
 - Some underway solutions available
- Frequency of cleaning
 - Proactive vs. reactive





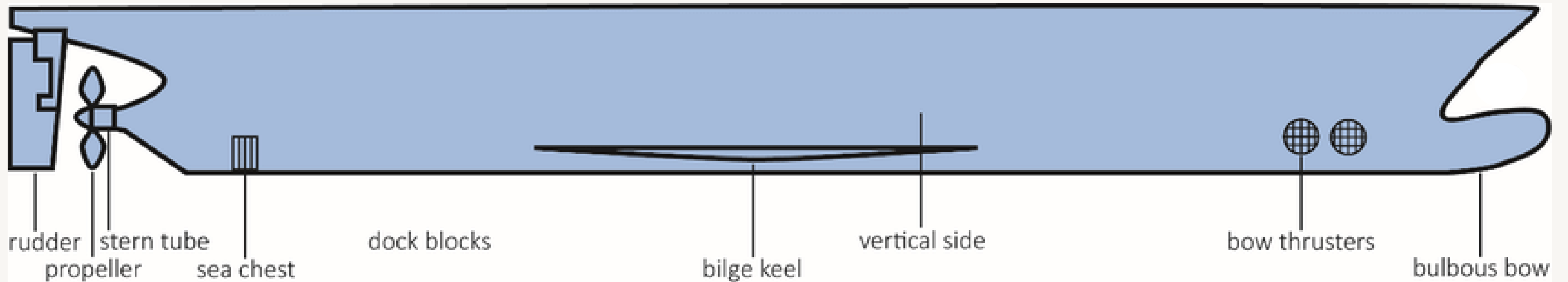
ROI*

- Hull maintenance has a return on investment
 - Fuel savings
 - GHG - easy and early win



*Return on investment

ROI: NICHE AREAS



Jeanne Gunther in Davidson et al.

- Smaller return on investment

BIOFOULING MANAGEMENT: IN-WATER CLEANING WITH CAPTURE



BIOFOULING MANAGEMENT: HULL CLEANING



The screenshot shows the top portion of a news article on the Marine Technology News website. The header includes the site name 'MARINE TECHNOLOGY NEWS' and a navigation menu with 'Home' highlighted. Below the header is a secondary navigation bar with categories: 'Offshore Energy', 'Hydrographic', 'Ocean News', 'Subsea Defense', and 'Vehicle News'. The article is by Wendy Laursen, a contributing writer with over 20 years of journalism experience. The date is November 6, 2025. The main headline is 'Money Pours in for Hull Cleaning Technology'.

MARINE
TECHNOLOGY
NEWS

Home Magazine Directory Events Podcast Videos Advertising

Offshore Energy Hydrographic Ocean News Subsea Defense Vehicle News

 **Wendy Laursen**, Contributing Writer
Wendy Laursen has more than 20 years of experience as a journalist....

November 6, 2025

Money Pours in for Hull Cleaning Technology

- Hullbot raised \$10.3M (November 2025)
- Neptune Robotics raised \$52M (September 2025)

CONFIDENCE

and

TRANSPARENCY

ISO 20679:2025

Ships and marine technology — Marine environment protection — Testing of ship biofouling in-water cleaning systems

ISO 6319:2026

Ships and marine technology — Marine environment protection — Conducting and documenting in-water cleaning of biofouling on ships



International
Organization for
Standardization

BIOFOULING CLEANING STANDARDS

GLOBAL SOLUTION

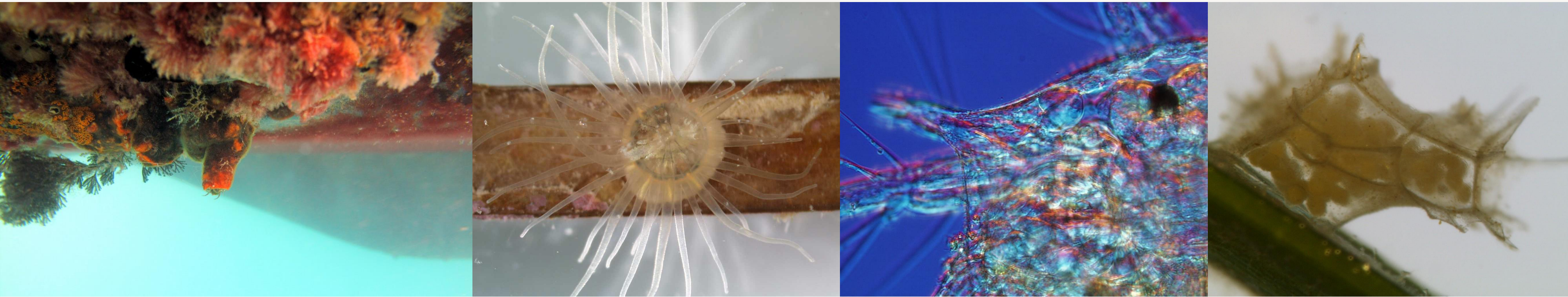


WHAT DOES THIS MEAN FOR PORTS?

More service providers will likely be
needed

Another consideration in
maritime domain awareness

CONCLUSIONS



Kim Holzer, SERC

Lisa Drake, DMES

- Biofouling is a common, natural process
- Managing ships' biofouling has multiple benefits
- More technological solutions (\$ flowing)
- Regulation, standardization, and transparency
- **Port operators** can assume that more in-water cleaning or maintenance providers will be needed in the future



THANK
YOU



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